PART 9

SELECTED CARDIAC DISORDERS

CHAPTER 44

Aortic Stenosis

KEY TEACHING POINTS

- The characteristic murmur of calcific aortic stenosis radiates broadly from the cardiac apex to the right clavicle. The *absence* of this murmur is a compelling argument *against* the diagnosis of aortic stenosis.
- The classic physical findings of aortic stenosis—delayed carotid upstroke, diminished intensity of the second heart sound, sustained apical impulse, and late peaking murmur—all increase the probability that the murmur represents moderate-to-severe stenosis (and not a more benign aortic flow murmur).
- Clinicians will have difficulty using bedside findings alone to distinguish moderate aortic stenosis from severe aortic stenosis.

I. INTRODUCTION

Aortic stenosis is any disorder of the aortic valve that obstructs the ejection of blood from the left ventricle into the aorta. Its characteristic findings are a systolic murmur, abnormal carotid pulse, and sustained apical impulse.

The pathology of aortic stenosis was recognized in the 1600s, but it was James Hope who in 1832 first clearly described the characteristic murmur.[1,2]

II. THE FINDINGS

A. THE MURMUR

The murmur of aortic stenosis is early systolic, midsystolic, or holosystolic. Although it may be loudest at the right second intercostal space (i.e., the classic "aortic" area), most aortic stenosis radiates above and below the third left parasternal space,

obliquely and upward toward the right clavicle and downward toward the apex, a distribution mimicked by placing a sash over the patient's right shoulder. Radiation of sound in the neck first appears on the right side (clavicle and neck), but as the stenosis worsens the sound appears on *both* sides of the neck and over both clavicles (i.e., isolated radiation to just the *left* clavicle or *left* neck is not characteristic of aortic stenosis and instead suggests stenosis of a great artery; see Chapter 43).

In calcific aortic stenosis, the most common modern etiology, the murmur at the upper sternal borders contains both high- and low-frequency vibrations, giving it a harsh or rough sound, like that of a person clearing the throat. In contrast, at the apex the murmur of calcific aortic stenosis sometimes loses low-frequency components and instead consists of a narrow band of high-frequency sound, thus making it sound like mitral regurgitation. This harmonic distortion of sound—the loss of low-frequency components of sound when the stethoscope is moved "upstream" toward the apex—is called the **Gallavardin phenomenon**.[3]

B. ASSOCIATED CARDIAC SIGNS

Other traditional findings of severe aortic stenosis are the following: (1) a carotid pulse that is abnormally small in volume and delayed (**pulsus parvus et tardus**); (2) a palpable apical impulse that is abnormally sustained (see Chapter 38 for definition of sustained impulse); and (3) reduced intensity of the second heart sound, which occurs because the inflexible aortic leaflets close with less force than normal. Another traditional finding is a prominent A wave in the neck veins (i.e., the **Bernheim phenomenon**), although this wave is more often seen on pressure tracings than at the bedside. Its mechanism is disputed.[4]

III. CLINICAL SIGNIFICANCE

A. DETECTING AORTIC STENOSIS

The presence of the characteristic aortic systolic murmur increases the probability of aortic stenosis (likelihood ratio [LR] = 5.9 for mild or worse aortic stenosis; EBM Box 44.1); most false-positives (i.e., patients with a characteristic aortic murmur but no aortic stenosis) have increased aortic flow without obstruction (e.g., from fever, anemia, pregnancy, or turbulence due to nonobstructing calcification). Most importantly, the *absence* of the aortic flow murmur decreases considerably the probability of aortic stenosis (LR = 0.1 for stenosis of any severity). Chapter 43 discusses further the differential diagnosis of systolic murmurs and how the clinician—by observing the location of sound, the second heart sound, the quality of the murmur, and how the murmur responds to irregular heart beats and different maneuvers—can be more confident a systolic murmur indeed represents aortic stenosis and not another valvular lesion.

B. SEVERITY OF AORTIC STENOSIS

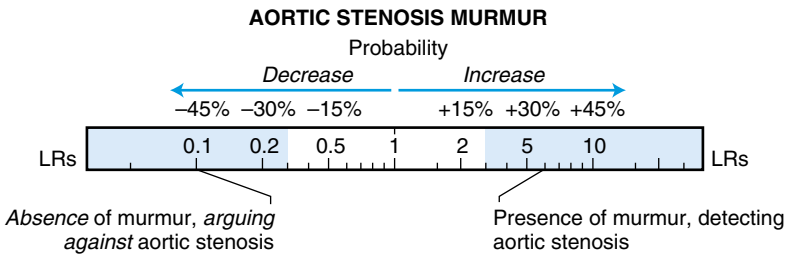
After clinicians are confident a murmur represents an aortic flow murmur, they must decide whether or not the patient has significant aortic stenosis. Significant aortic stenosis refers to those lesions with such severe obstruction that, if the patient has symptoms of angina, syncope, or dyspnea, valvular replacement is indicated. (The footnotes of EBM Box 44.2 define severe stenosis.)

Many of the traditional teachings about aortic stenosis originated during a time when congenital and rheumatic diseases were more common than they are today. Because the primary cause of aortic stenosis currently is calcific aortic

EBM BOX 44.1
*Aortic Stenosis Murmur**

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	Likelihood Ratio‡ if Finding Is	
			Present	*Absent*
Aortic systolic murmur, detecting mild or worse aortic stenosis[5]	90	85	**5.9**	**0.1**
Aortic systolic murmur, detecting severe aortic stenosis[5-7]	83-98	71-75	**3.5**	**0.1**

*Diagnostic standard: For *mild or worse aortic stenosis,* peak aortic velocity ≥2.5 m/s; for *severe aortic stenosis*, maximal inter-aortic cusp distance 8 mm,[6] peak aortic velocity 4 m/s,[5] or peak aortic gradient >64 mm Hg.[7]
†Definition of findings: For *aortic systolic murmur,* either the broad apical-base pattern or small apical-base pattern (see Chapter 43).
‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
Click here to access calculator



EBM BOX 44.2
*Characteristics of Severe Aortic Stenosis (All Patients Have Aortic Murmur)**

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	Likelihood Ratio‡ if Finding Is	
			Present	*Absent*
Arterial Pulse				
Delayed carotid artery upstroke[5,8-12]	31-91	68-93	**3.5**	**0.4**
Reduced carotid artery volume[5,9,10]	44-80	65-81	2.3	0.4
Brachioradial delay[13]	97	62	2.5	**0.04**

Continued

EBM BOX 44.2
Characteristics of Severe Aortic Stenosis (All Patients Have Aortic Murmur)—cont'd*

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	Likelihood Ratio‡ if Finding Is	
			Present	*Absent*
Apical Impulse				
Sustained apical impulse[9]	78	81	**4.1**	**0.3**
Apical-carotid delay[14]	97	63	2.6	**0.05**
Heart Tones				
Absent or diminished S_2[5,8,10-12,15]	44-90	63-98	**3.8**	0.4
S_4 gallop[11,16]	29-50	57-63	NS	NS
Murmur				
Grade ≥3 of 6[5,17]	31-89	23-77	NS	NS
Early systolic timing[5]	4	61	**0.1**	1.6
Prolonged duration[5,8,11]	83-94	49-84	**3.0**	**0.2**
Late peaking[8,9,11,12]	83-91	70-88	**3.7**	**0.2**
Loudest over aortic area[10,11]	58-75	41-73	1.8	0.6
Radiation to neck[5,10-12]	90-98	11-51	1.4	**0.1**
Radiation to both sides of neck[5]	50	74	1.9	NS
Blowing quality[5]	4	67	**0.1**	1.4
Humming quality[5]	62	71	2.1	0.5

*Diagnostic standard: For *severe aortic stenosis*, aortic valve area <0.6 cm^2/m^2,[12] <0.75 cm^2,[13,15] <0.8 cm^2,[10,14] <0.9 cm^2,[9] peak gradient >50 mm Hg,[10,11] or aortic flow peak velocity >3.6 m/s,[8] or ≥4 m/s.[5]

†Definition of findings: For *late peaking murmur,* murmur peaks at mid systole or beyond; for *aortic area,* second right intercostal space.

‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.

NS, Not significant.

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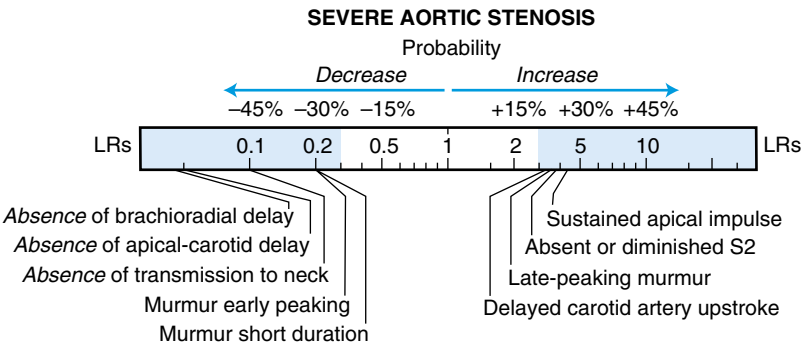

stenosis, some of these teachings may not be as relevant as they were in the past. In comparison to congenital and rheumatic disease, calcific aortic stenosis affects older patients, who commonly have aortic flow murmurs *without* stenosis (i.e., aortic sclerosis) and who often have ischemic heart disease, a disorder complicating the bedside evaluation because patients then have two possible explanations (i.e., severe aortic stenosis or ischemic heart disease) for symptoms of angina or dyspnea.

The patients whose clinical signs are summarized in EBM Box 44.2 (more than 700 patients in all) were all elderly. Importantly, *all had aortic flow murmurs*, and the bedside question was whether or not the murmur represented *severe* aortic stenosis. Although some had mild aortic regurgitation, other significant valvular disease was excluded from most of these studies. In these studies, syncope was the only classic aortic stenosis symptom that increased the probability of severe aortic stenosis (LR = 3.1; the LRs for the other two classic aortic stenosis symptoms, angina and dyspnea, were not significant).[9,17,18]

1. INDIVIDUAL FINDINGS

The following findings, in descending order of diagnostic accuracy (see EBM Box 44.2), increase the probability of severe aortic stenosis in patients with aortic flow murmurs: sustained apical impulse (LR = 4.1), absent or diminished S_2 (LR = 3.8), late peaking murmur (LR = 3.7), delayed carotid artery upstroke (pulsus tardus, LR = 3.5), prolonged murmur (LR = 3), apical-carotid delay (i.e., a palpable delay between the apical impulse and carotid impulse, LR = 2.6), brachioradial delay (i.e., palpable delay between the brachial and radial artery pulses, LR = 2.5), reduced carotid artery volume (i.e., pulsus parvus, LR = 2.3), and a murmur with an added humming quality (LR = 2.1).

The findings that *decrease* the probability of severe aortic stenosis in patients with aortic flow murmurs are: absence of brachioradial delay (LR = 0.04; see EBM Box 44.2), absence of an apical carotid delay (LR = 0.05), early systolic timing (LR = 0.1), blowing quality throughout (LR = 0.1), lack of radiation to the neck (LR = 0.1), and short duration of the murmur (LR = 0.2). Brachioradial delay and apical-carotid delay were each investigated in only single studies and thus require confirmation by others.

Two additional bedside findings are chest radiography (CXR) and electrocardiography (ECG). The finding of calcification of the aortic valve on CXR detects severe stenosis with a sensitivity of 31% to 81%, specificity of 63% to 96%, positive LR of 3.9, and negative LR of 0.5.[10,15,17,18] Left ventricular hypertrophy on ECG detects severe stenosis with a sensitivity of 49% to 94%, specificity of 57% to 86%, positive LR of 2.1, and negative LR of 0.5.[8,10,14,15,17,18]

The following findings are not helpful in identifying patients with severe aortic stenosis: narrow pulse pressure,[19] fourth heart sound, third heart sound,[15] reversed splitting of the second heart sound,[11] aortic ejection click,[11] and intensity of the murmur (see EBM Box 44.2).

2. WHY POSITIVE LIKELIHOOD RATIOS ARE SO LOW

The highest positive LR for the findings listed in EBM Box 44.2 is 4.1 (i.e., sustained apical impulse). In general, positive LRs are low when patients *without* disease also demonstrate the physical finding (i.e., specificity is low and there are many *false-positive* results). The cause of false-positive results in the studies of aortic stenosis is principally *moderate* aortic stenosis (defined as aortic valve area of 0.8 to 1.2 cm^2 or peak gradient of 25 to 50 mm Hg).

Therefore, if "disease" is instead defined as "combined moderate-to-severe aortic stenosis," the positive LRs improve dramatically, especially for delayed carotid

upstroke (positive LR = 7.6, negative LR = 0.5), absent or diminished S_2 (positive LR = 7.4, negative LR = 0.5), prolonged duration of murmur (positive LR = 11.4, negative LR = 0.3), and late peaking murmur (positive LR = 13.7, negative LR = 0.3).[5,8,11,12,20]

This means that the clinician examining patients with aortic flow murmurs can easily distinguish patients with moderate-to-severe aortic stenosis from those with milder stenosis or no obstruction, but they have greater difficulty distinguishing severe stenosis from those with moderate stenosis.

3. COMBINED FINDINGS

One study has validated the use of combined findings in the diagnosis of aortic stenosis.[10] According to this diagnostic scheme, the clinician evaluates five bedside findings and assigns the following points: delayed carotid upstroke (three points), diminished carotid volume (two points), murmur loudest at right upper sternal border (two points), single or absent second heart sound (three points), and calcification of the aortic valve on CXR (four points).

This diagnostic scheme distinguishes moderate-to-severe aortic stenosis from other causes of aortic flow murmurs. The probability of moderate-to-severe aortic stenosis is low with 0 to 6 points (LR = 0.2) and high with 10 to 14 points (LR = 10.6). Scores from 7 to 9 points are unhelpful (LR not significant).

The references for this chapter can be found on www.expertconsult.com.

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